ROLE OF LIBRARIES IN MEDICAL EDUCATION*

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PREVIOUS SPEAKERS have eloquently addressed the basic questions facing information management today. We have heard about the problems of the information explosion and ways to deal with it. And we have heard about the problems of organizing and accessing the medical literature and how new developments in information technology offer solutions. It is now my assignment to discuss the role of libraries in medical education and, concomitantly, how to evaluate the library's ability to fulfill that role.

While it may be the epitome of banality to discuss the role of the library in medical education, considering the historical and prevailing opinion that the library is the heart and soul of the university, yet I submit that that opinion may be one of our problems. I say that, not because I would choose to discard that high-value status, but more because I feel that the status is founded on old and outworn principles. And these principles are major impediments to the type of changes in information management and roles in medical education which libraries can and should play in today's medical educational environment.

In support of this premise, and to deflect some potential hostility from me to one of my colleagues, I refer to an article written by Herbert S. White, Dean and Professor at the School of Library and Information Science, Indiana University, which appeared in the September 1, 1987 issue of *Library Journal*.[1] In describing the difficulties facing research libraries in these days of expanding information and declining funds, Dean White described faculty members and administrators who loved libraries but who trivialized librarians by, often as not, trampling librarians underfoot as expendable when it came to preserving collections. This is done in the name of the sacred materials budget and results in a cost saving approach that diverts funds from people and services to collections in an attempt, no matter how futile, to placate the

faculty's demand to have everything in their specialty in the library. White continues by explaining that librarians provide the interactions for which they are uniquely prepared: analysis, search, organization, repackaging, and use. When university administrators transfer funds from the librarian to the materials budget, their priorities are clear. And those priorities are to maintain collections in the benevolent but misguided notion, first articulated by Carlyle, that the true university is a collection of books. Yet even when the rest of the library budget is sacrificed on the altar of the collection budget, the gift is poisoned, because a collection of books and journals without the professional library staff to interpret it for students and faculty is merely a warehouse.

Thus, I shall focus the rest of my remarks on the role of librarians in medical education rather than libraries because it is my premise that the medical librarian is a vital partner in medical education and that it is the qualitative evaluation of information services, not quantitative evaluation of library collections, that is important.

I shall attempt this redirection of principles by describing some needs that are appearing as a result of emerging trends in medical education by analyzing the needs reflected by the Harris Survey and by examining some solutions available through the systematic application of information systems and services via the medical library. I shall conclude with a new paradigm for medical libraries and librarians as partners with their faculty colleagues in the educational process.

NEEDS AS REFLECTED BY TRENDS IN MEDICAL EDUCATION

While there have been numerous articles, reports, and conferences on new directions in medical education, two benchmark publications anchor this topic. The first, appearing in 1984, is the now famous (or infamous) General Professional Education for Physicians (GPEP) Report, *Physicians for the Twenty-First Century*.[2] Although I am sure that each of you is thoroughly familiar with this report and its recommendations, a summary of its main points relevant to my topic may be worthwhile:

Conclusion 1. "The general professional education of the physician begins in college, continues through medical school, and extends into the early period of residency. Its purposes are to enable students to acquire the knowledge, skills, values, and attitudes that all physicians should have; and to develop the abilities all physicians need to undertake limited responsibility for patient care under supervision during the early period of their residency."

Conclusion 2. "Vital to these purposes are...skills in the collection of information from and about patients, in the establishment of rapport with

patients to facilitate both diagnosis and therapy, in the application of the scientific method to the analysis, synthesis, and management of problems, in the identification and critical appraisal of relevant literature and clinical evidence, and in the continuation of effective learning."

Conclusion 3. "To keep abreast of new scientific information and new technology, physicians continually need to acquire new knowledge and learn new skills. Therefore, a general professional education should prepare medical students to learn throughout their professional lives rather than simply to master current information and techniques. Active, independent, self-directed learning requires among other qualities the ability to identify, formulate, and solve problems; to grasp and use basic concepts and principles; and to gather and assess data rigorously and critically."

The second of these publications, *Medical Education in the Information Age: Proceedings of the Symposium on Medical Informatics*, appeared two years later, in 1986.[3] Again I shall summarize the main relevant points from Part I: Agenda for Action.

Recommendation 1. "Medical informatics should become an integral part of the medical curriculum. The teaching of medical informatics should include opportunities for specific instruction in its fundamentals as well as adequate examples of its application throughout the medical curriculum."

Recommendation 2. "There should be an identifiable locus of activity in medical informatics in academic medical centers to foster research, integrate instruction, and encourage appropriate use for patient care."

Recommendation 3. "Training and career development in medical informatics must be fostered by a series of coordinated actions."

Assuming, somewhat naively, that these two publications can stand for the developing trends in medical education, what needs can be identified from them? One of the major skills or abilities called for by the GPEP Report is the collection and application of information, including identification and critical appraisal of relevant literature. And this need will continue throughout the professional career of the physician. Students who have been taught to seek information as part of their learning will need easy access to information throughout their careers to continue their education. Information management systems will be of greater value than periodic, short courses in assisting practicing physicians in the pursuit of new knowledge. To achieve this goal, information management principles and skills must be an integral part of any medical curiculum.

Incorporating information management skills in the curriculum requires active leadership by medical educators. The GPEP Report includes the fol-

lowing recommendation: "Medical schools should designate an academic unit for institutional leadership in the application of information sciences and computer technology to the general professional education of physicians and promote their effective use." The emphasis here is on the need for information seeking and information management skills on the part of students, which will be best accomplished through the curriculum.

The recommendations from *Medical Education in the Information Age*[3] identify similar needs. There is a need to make medical informatics an integral part of the medical curriculum, including the use of medical informatics techniques in instruction. A central locus of activity for medical informatics is needed to support this new curricular effort. And training in the techniques of medical informatics needs support within the educational environment.

The needs for information and information management skills, recognized by these two reports, reflect the growing changes in our larger society. Daniel Bell first articulated those changes in his characterization of the postindustrial society as information-producing rather than goods-producing and where the motivating force is information power, not machine power. Medicine and medical education, for more than 60 years, has reflected this change. But it was reflected primarily by acknowledging the quantity of factual information needed both to learn and to practice medicine. That recognition has led to the traditional medical education we see today, the attempt to transfer a large body of facts to the student in the hopes that when a particular problem presents itself, the new physician will be able to synthesize a decision by rummaging around in those facts and coming up with the answer. That approach has led to a garbage can model of decision making. That is, today's physician has a number of solutions, as represented by the particular body of facts remembered, in search of a problem. And the tendency, albeit subconscious, is to define the problem in terms of the individual's knowledge base. The extent to which any individual physican can hold in memory a large number of facts or fact-combinations, i.e., the size of the knowledge base, determines the success of the solution.

Changing trends in medical education are an attempt to recognize this problem and to seek solutions through the application of new techniques of information technology. They are an attempt to replace the garbage can model of medical decision making with a problem solving approach, i.e., first the problem is identified and then information is sought which bears on the problem and leads to an effective decision. Thus we are now seeing attempts to teach medical students information seeking skills rather than to teach them an ever growing body of facts. These new information seeking

skills go beyond the identification of the major text or reference books and specialty journals in the field. They encompass the structure and organization of knowledge, its storage and retrieval, and its management for application to the clinical or research decision process. Today's students and tomorrow's physicians will have a range of sophisticated information management systems available to bring to bear on the practice of medicine.

These new directions in the use of information have led to new demands for learning information management skills. And this, in turn, has led to a new role for medical libraries. Whereas, historically, the library has been viewed as a repository of information, it is now developing a role as purveyor of information. Rather than serving as a passive storehouse of books and journals, it is becoming a dynamic organization with an emphasis on information management. And this new role is equally stimulated by both the proliferation and increasing cost of books and journals. Since no library today can hope to acquire all materials, the need now is for access, access to a selected body of literature in the library, closely related to the primary needs of the institutional users, and access to materials in other libraries in a rapid and cost-effective fashion. Thus the library is evolving two new roles. The first is educational wherein the library assumes a growing responsibility for instructing students in information management skills and consults with faculty members on information management problems. The second is as an information broker, with access to other repositories of information, both within and without the institution, and with electronic means to retrieve and to deliver this information.

And so information is playing a new and larger role in medical education. And the library, the historical source of organized information, is developing a new role that reflects this development. And the library's challenge is to identify new needs and demands for information services and to respond to them.

NEEDS AS REFLECTED BY THE SURVEY

I shall now turn to some of these new (or perhaps old and continuing) needs as identified by the Harris Survey.[4] The first set of needs pertains to the information explosion, detailed in Chapter 3 of the Harris Survey.[4] While this topic appears last in the report of the survey, it is the starting point for my analysis.

As reported in the Executive Summary, observation No. 6 reads as follows: "Despite the exponential growth of information, the majorities of all user groups (basic science and clinical faculty, medical students, residents, and office-based physicians) felt that ALL materials of both potential schol-

arly interest and clinical relevance should be kept in medical school libraries, regardless of how often they are used. Deans and librarians were much less certain that this is appropriate.'' This single observation serves both to sum up the historical principle which, as I noted above, has driven most views of the library as well as reflect some ambivalence and contradiction in the views expressed by the participants of the survey. The concept that all information must be kept close at hand reflects the view of the library as a storehouse rather than as a deliverer of information. The ambivalence and contradiction are reflected by contrasting this response with observation No. 7: ''The only suggested measure to increase efficiency and cut costs that would be willingly accepted by a majority of any group is sharing of collections with other institutions.'' This statement clearly reflects a transition stage conceptualizing information where, intellectually, library users know that it is not possible to collect in one library all the information of potential use, but emotionally are reluctant to give up their historical relationship with the library as a repository of all the information they will ever need or want.

Two needs can be extrapolated from these observations. The first is the need to orient and to educate library users to the impossibility of ever returning to those days when all the potentially useful information could be collected within the walls of a single library. The second is to inform them that other solutions, some in the form of compromises, can be brought to bear on the problem. These solutions involve application of information technology and reconfiguration of the library from warehouse of information, represented by what is in the collection, to an access center to information in other collections. I would submit that the major problem in meeting these needs will be a marketing problem, in that libraries and their parent institutions will have to inform their user publics of the new realities of information access. The second, and not inconsequential, problem will be to equip the library with the technology to serve in the capacity called for by this reconfiguration.

My belief that these ''marketing issues'' will be most important is buttressed by the following observation from the Harris Survey: ''While user groups, deans, and chief librarians recognize that, in the light of the 'information explosion,' some changes need to be made regarding types and amounts of information stored, users are noticeably the most uncomfortable in letting go of information that's already on hand.... Users still prefer to hold on to past and current publications, while deans and librarians are more willing to re-examine past and current as well as future output.'' With regard to the technological solution, the following observation gives one pause: ''Although...there is a broad consensus behind the idea that medical libraries

should be judged on their retrieval systems rather than simply on the size of their collections, there is not much of a sense among either the user groups, librarians, or deans that lack of an efficient retrieval system or an emphasis on the quantity rather than quality in collections are problems today.''

The proportion of respondents rating this problem as even somewhat serious does not reach the 50% mark. If the prevailing opinion of our users is that all materials of potential value, both past and future, should be available in the library and that, while important, lack of an efficient retrieval system is not a great problem, then I firmly believe that we have a massive information task ahead of us. For if we are not able to reorient our users to a new paradigm of the medical library, we are doomed to mediocrity for we will not be able to obtain either the financial or physical and space resources needed to meet their expectations, or the support to implement the technology that might.

The second set of needs relate to how medical professionals get information. Four observations relevant to my topic are provided in the Executive Summary.

Observation No. 10 states: "Medical school faculty have the greatest access to personal computers, though substantial majorities of other user groups also own or have access to a personal computer. However, about a third of all medical students, residents, and office-based physicians neither own nor have access to a personal computer.''

Observation No. 11: "Access to online databases is almost universal in the medical community: 77% of basic scientists, 80% of clinical researchers, 78% of residents, 67% of medical students, and 62% of office-based physicians have used these in the last 12 months. However, of those users who have access to online computerized databases, 55% of medical students, 54% of office-based physicians, 46% of residents, 44% of basic science faculty, and 43% of clinical faculty rarely or never use the databases in the library to track down specific types of information.''

Observation No. 12: "Medical professionals and students are still quite dependent upon the printed word as a reference source. Overwhelming majorities say their own printed sources are still the media most often used when they need to track down specific information.''

Observation No. 13: "Overall, office-based physicians appear to be the least well informed members of the medical community. They annually read the fewest number of books; over half of them who have access to a medical school library use a hospital library (which is less well stocked) instead; 26% of them don't have access to databases, and of those who do, 37% haven't used one in the past year.''

What are the needs arising from this set of observations? The first can be characterized by the general term "computer literacy." By this I mean not only familiarity with using a computer and selected software, but also the ultimate migration of the personal computer throughout the ranks of medical professionals. I shall go out on a limb and predict that in 10 years absolutely no medical student or professional will be without access to a personal computer. Obviously, by then all will be equally literate in, at least, a small number of applications. Thus this need will be met, partly, by the normal transfer of technology throughout this segment of society, much as occurred with the telephone. The other part of this general computer literacy need, however, will require active attention in the form of either formal or continuing education. If in 10 years all medical professionals have and use personal computers, will they be using them for bibliographic or information management purposes?

The second observation does not leave me very sanguine in regard to this question. The obvious need arising from this observation is for greater educational efforts in the application of personal computers to information retrieval and management. If substantial numbers of medical professionals with access to on-line data bases still do not use them to obtain specific information, there is some need there that must be met. I assume that it is educational but more may need to be known about this reluctance before that can be determined. And here another contradiction between belief and behavior occurs, for this lack of use of on-line retrieval systems, a behavior that seems odd when contrasted with the following statement of belief: "The information explosion in the medical sciences has made computerized information systems technology an essential component in a university, medical school or hospital." If the belief in the value of the on-line system is widely held, why is that belief not actualized by using such systems when seeking information?

Perhaps this contradiction is explained by the next observation about dependency on printed media. Here the need again seems to be for information or education as to how information technology can provide the needed information. Reliance on one's own printed sources is a traditional response and one that had merit when an individual could collect in a personal or office collection most books and journals in a given specialty. Today, the combination of a proliferation of materials with interdisciplinary approaches makes such an attempt fruitless. Yet this response continues. The need appears to be for increased development of effective information retrieval systems and a greater distribution of such systems to places where medical professionals practice. Emphasis on the printed material, I believe, is because it is both

familiar and close at hand. When information systems acquire these two characteristics, they will be substituted.

The needs arising from the last observation on the lack of knowledge of office-based physicians are essentially the same as those arising from the first three. There is obvious need for computer technology to migrate to the physician's office. There is a need to teach office-based physicians to use information technology and since all of these individuals were once medical students, a curricular effort would ultimately eliminate this need. And there is a need for distributed, easy-to-use information systems accessible through telecommunications.

I now turn to the question of evaluating medical schools and their libraries. Two observations in the Executive Summary bear on this question. Observation No. 4: "The size of a library's collection should not be the main measure of its quality. Not only is size no longer an adequate or fair measure of quality, but at least eight in ten of all users and 98% of deans say the power in the library's access and retrieval technology is vital. Chief librarians are also nearly unanimous in their agreement." Here we see yet another contradiction because it is difficult to reconcile this observation with those discussed above which reflect the opinion that libraries should collect and retain all information of potential need, that substantial numbers of users do not use retrieval systems, and that users still depend upon printed material.

And observation No. 5 states: "Medical school deans see the quality of the library and information retrieval facilities as being of only middling importance in determining the overall standing of a medical school. They place much greater emphasis on other factors, such as the quality of the hospital with which the school is affiliated and the academic credentials of the faculty. On the other hand, they feel that the medical school accrediting committee places much more importance on the quality and direction of the curriculum and the caliber of the school's students." There is no contradiction here with the previous observation because these two observations refer to different issues. The first refers to opinions about the quality of the library as a unit within the medical school, whereas the second refers to the quality of the medical school itself. It is certainly reasonable to view the library as less important to the quality of the medical school than other factors while still holding the opinion that the quality of the library is related to the availability of information retrieval systems. I would not propose that the quality of the school should primarily rest on the quality of the library.

So what needs can be determined from these observations? The first is that if size alone is not a good measure of quality, what do we use? We need to

determine a new set of criteria whereby to evaluate libraries that will take into account the new role that libraries can and will play in medical education. And these new criteria should focus on the library's information retrieval systems, services, and access capabilities. And, even if the quality of the library does not become the primary measure of the quality of the medical school, perhaps it will be viewed as more significant insofar as information management skills become an educational objective.

Although the survey ranged over a wide variety of topics, at least two were not covered. One is the issue of the utility of the information sought and retrieved. It seems important to determine the purpose that the information served and how well it served that purpose. This issue may be at the bottom of the observation that libraries should collect and retain all material because selecting a subset of the literature presupposes that the library is aware of the purposes served by the information sought and has that information available. Since it is difficult to know how the collection will be used, the best approach is to try to have everything of possible use. Thus there is need to investigate how information is used to be more effective in acquiring that information.

The second issue is the role of other information resources that exist within and without the institution and the library's role in brokering or coordinating access to these other resources. The concept here is the Integrated Academic Information System (IAIMS) as described by Matheson and Cooper[5] and about which I shall have more to say later. The need here is to determine the extent to which information resources, other than the library, are known, available, and accessible. It is also important to determine how such coordination or integration should be accomplished and what role the library has to play in this activity.

We must also be aware of the attitudinal nature of the observations expressed by the individuals surveyed. While the survey was done in a systematic and appropriately controlled fashion, it was, nonetheless, a questionnaire survey and sought opinions. It, therefore, is subject to all of the caveats of questionnaire research. It is because of this nature of the survey that the apparent contradictions in the various response categories do not bother me very much. These opinions are valuable although I know that opinions are often formed on less than adequate knowledge. Therefore, one of the most significant needs I perceive from the responses is the need for better publicity by the library about information resources and information systems. As librarians we need to tell our story more effectively if we want users of information to be sophisticated consumers. And we need to tell that story in some structured and systematic way. The implication here is that there is a

new role for the library in medical education and that role is as a partner in the educational process providing instruction, both formal and informal, in information management.

SOLUTIONS AVAILABLE THROUGH INFORMATION SYSTEMS/LIBRARIES

Having identified a variety of needs, it is now time to turn to mechanisms available to meet these needs. I propose that the application of information technology and librarians and libraries, in concert with medical school administration and faculty members, offer some solutions. We have already heard of some of the developments in information technology applicable to the needs and there is insufficient time to review this area comprehensively. It will have to suffice to mention lower cost, greater power, parallel processing architecture, increased storage, new storage media, e.g., optical discs, CD-ROM, WORM, etc., and advances in telecommunications and telecommunications protocols including mixed vendor networks. While any one of these would suffice to drive major improvements in the utility of information technology, their combination is generating nothing short of a revolution in the way information is managed.

And new developments are not limited to hardware because futuristic software applications are being developed simultaneously. There is a true symbiosis as new developments in hardware capability drive new developments in software followed by the needs of the software developers for greater capability driving further hardware developments. I return to *Medical Education in the Information Age: Proceedings of the Symposium on Medical Informatics, Part II: The state-of-the-art in medical informatics*[3] since it provides the most comprehensive review of new development in applications of information systems technology, I shall summarize or quote.

The first area is medical literature databases, of which MEDLINE is the best known and represents the state-of-the-art. A number of improvements can be made in such systems, however. Search techniques can be made both more sophisticated and easier to use. Scope and currentness can be improved. Quality control both on input and for errata can be implemented. Visual information in the form of diagrams or photographs can be added to the textual information. And a capability for browsing the database could be developed. '' ... the future holds the potential for much wider use of medical literature databases. We may expect to see the distributed use of these databases employing technologies such as the optical disc with extremely high storage capacities. Visual information such as diagrams and photographs will accompany the full text of articles in the database. Further, there

will be significant improvements in the technology of indexing and searching these databases that will allow more natural methods of literature searching and online publishing may become an important source for the distribution of medical knowledge.''

The second area is that of medical information systems (MIS). A clinical MIS is, essentially, an automated medical record. Its common elements are the collection, organization, and reporting of patient-specific clinical information. This information is used in a variety of ways to support clinical services, institutional management, and clinical research. While the clinical MIS is an integral part of most clinical practice settings, and significant advances have been made in their functionality, improvements in certain areas could increase their utility. Improvements in the techniques of data collection, scope of data acquired, flexibility of the database structure, and methods to present information to the users are both desirable and possible. ''Clinical MIS will play an increasingly important role in medical care. The growing demands for information in various forms will be met primarily by computer-based MIS. Given that important improvements can be accomplished such as the development of a standard medical terminology, the way is open for the development of comprehensive patient databases with standardization of database structure and interfaces. The data acquisition process will be automated to a greater extent and we will see greater flexibility in the information retrieval process. The standardization of databases will also lead to the development of nationwide databases for research purposes that can automatically draw on MIS systems in institutions throughout the country. Finally, we can expect to see the introduction of medical reasoning into such systems along the lines of the HELP system and a greater support for the physician in the decision-making process. However, this will also mean that such systems are capable of a larger role in monitoring the care of individual patients and providing information for such institutional concerns as quality assurance and fiscal control.''

Computer-assisted medical decision-making is the third area and the most difficult to summarize. It is also the area in which the computer, rather than serving as just a repository of information, plays the most active role. The development of such systems stems from a desire to improve clinical decision making by systematizing the process and in most cases using the computer to apply it. These systems are designed to assist physicians to cope with and effectively to use the large amount of information available in today's medical world. There are four broad categories of computer-assisted medical decision-making systems: clinical algorithms, statistical pattern classification, decision analysis, and expert systems.

Clinical algorithms can make a significant contribution to health care provided by physician extenders. They work best in situations where the logic of diagnosis and treatment is straightforward. Where complexity is present, the algorithm refers the case to a physician. These systems are the simplest, and other methods of computer aided decision making are necessary in more medically complex situations.

Statistical pattern classification uses mathematical approaches, e.g., linear regression, stepwise discriminant analysis, or Bayesian classification to predict a diagnosis. The particular approach is first derived on a large group of patients with known characteristics and the derived function can then be applied to new patients. In many instances such systems have outperformed clinicians.

Decision analysis is based on the rational human decision making process. Using decision trees and utility analysis, it attempts to calculate the probabilities of particular outcomes. Decision analysis is an important approach since it attempts to provide a process for making rational decisions that take into account both the probability and the value of particular medical outcomes.

Expert systems, the last broad category of computer-assisted medical decision-making systems, is an attempt to program a computer to emulate expert human problem solving. These systems use symbol manipulation and are based on research in artificial intelligence. Expert systems have been developed as either rule-based or based on cognitive models. Expert systems attempt to assist the decision-making process with computer programs and have been successfully demonstrated in small, well-defined domain areas.

The area of such systems offers great potential for dealing with the information explosion. "It offers the promise of being able to collate and analyze information into a form that is useful for providing the necessary treatment for patients." But major research efforts are still needed and that is the primary focus of the field of medical informatics. Success in this area will reduce the need for physicians to act as information processors, providing them, instead, with freedom to focus on the human, qualitative aspects of medical care.

The fourth and last area of application of information system technology is computer-based education in medicine. This area is concerned with innovative, efficient, and cost effective means to support instruction. It is an educational technology with greater flexibility than any of its predecessors and promises significantly to enhance the educational environment. These systems range from simple drill and practice to complex simulations. And recent advances in hypertext-based systems are opening up dramatic new approaches. Until recently, the approach has been through large scale efforts

based on large, expensive time-sharing systems accessed through telecommunications. But advances in microcomputer capability offer less expensive options for locally developed systems.

While computer-based medical education has proven effective in selected applications, improvements in a number of areas would enhance its effectiveness and application. First is the economics of such systems since their implementation on large, expensive systems has restricted their development and application. The development of such systems on less expensive microcomputers should begin to alleviate this situation. The development of these systems would also be aided by a single authoring language. Without the need to learn complex programming languages to develop the system, faculty members could concentrate on content rather than the technology. The quality of interaction between the learner and the computer also needs improvement. Advances in microcomputer capability for presenting visual and verbal cues, so much a part of the teacher-student interaction, are needed. Here videodisc technology offers the mechanism for adding auditory and visual components. And last, the "not invented here" syndrome and improved methods of evaluating its efficacy need to be addressed.

The developments of computer-based medical education have followed the typical pattern of other innovations. First there was initial optimism. Second there was recognition of shortcomings. Third there was a re-evaluation and recognition that improvements were needed. And finally there is a general acceptance of those components with proved value. We are now in the third stage of this pattern. It is likely that the near future will see rapid developments in the application of this mode of instruction. Increasing availablity of low cost microcomputer systems, anticipated improvements in the mode of interaction between student and system, and greater focus on developing skills in problem solving and decision making will stimulate the design and adoption of such systems.

I have tried to show how new developments in information systems, stimulated by research in medical informatics, will provide new mechanisms to meet the information needs of medical students and health professionals. But these solutions, themselves, raise important issues. The major issue is, again, computer literacy. To use this new technology effectively will require teaching students its use and incorporating these applications in the educational process itself. Now it is time to turn to medical libraries and librarians to see what solutions they offer for meeting these information needs.

The obvious place to begin is with the National Library of Medicine, for it is the focal point of developments in medical libraries. It has served in a leadership role for more than 100 years, beginning with the first major printed

index to the world's medical literature and extending to its current endeavors in the application of information systems technology of which MEDLINE is the best known but not the only application. Medical libraries throughout the country and, to a great extent, throughout the world look to the National Library of Medicine for advances in mechanisms to meet new information needs. And as these new applications are developed they are disseminated through the transfer of technology to medical libraries, large and small.

In January 1987 the National Library of Medicine published its long range plan.[6] That plan identifies five domains of information management wherein continued or expanded activity or new developments will provide solutions to today's and tomorrow's information needs. Here again, I can only summarize. The first domain is in building and organizing collections. The goals are: to serve as the "library of record" for medicine and related sciences; to improve the organization and description of the biomedical literature; and to adapt existing methods for acquisition, organization, and preservation to accommodate new electronic forms of the scholarly record of biomedicine.

The second domain addresses locating and gaining access to medical and scientific literature. Here the goals are: to make information more accessible to health professionals; to provide enhanced information products and services to assist health professionals and biomedical scientists; to continue to support the training of medical librarians and other information specialists to prepare them to adapt new technologies to the needs of the biomedical community; and to review the public's need for and access to health information.

The third domain is obtaining factual information from data bases. The goals are: to expand information for public health and environmental protection; to establish information services and linkages for biotechnology information; and to support the development of medical practice-linked data bases.

Domain four concerns medical informatics. The goals are: to support extramural research on information and knowledge structure in the health sciences; to strengthen medical informatics research at the National Library of Medicine; and to strengthen competence in medical informatics in the health professions.

The fifth and last domain concerns assisting the education of health professionals through information technology. The goals are: to develop, demonstrate, and assess educational applications of computer technology in health sciences curricula; to develop and evaluate prototype knowledge management systems for use by persons in health sciences; and to evaluate the

National Library of Medicine's possible role as reference resource in support of automated systems to enhance learning in the health sciences.

These five domains and their associated goals address needs arising from trends in medical education and those revealed by the survey as described above. The first domain, building and organizing the collection, addresses needs resulting from the information explosion. With the National Library of Medicine the library of record and with its continued development of systems for rapid access and retrieval of items from its collection, pressure to collect all information at the local level is somewhat alleviated.

The domains of locating and gaining access to the literature and obtaining factual information from databases addresses needs of medical professionals for obtaining information. Expansion of both information products and services and of systems to access them will greatly assist medical libraries in meeting these needs for locating information.

And the domains of medical informatics and assisting health professional education through information technology address needs arising from new trends in medical education that call for both development of information technology leadership in medical schools and the application of information technology in the curriculum. Here the National Library of Medicine's leadership in both developing prototype systems and in providing extramural funding for research and development should greatly stimulate the dissemination of information systems technology.

But medical libraries are not standing and waiting for the National Library of Medicine to provide all the solutions to these new information needs of medical professionals. Rather, they have adopted a dynamic approach both in applying the most recent advances in information systems technology in their libraries and in expanding their roles within their institutions. And they have been stimulated to act and supported in their actions by two major initiatives.

The first was the publication of the Matheson report, *Academic Information in the Academic Health Sciences Center: Roles for the Library in Information Management*, which appeared in 1982.[5] This report, supported by the National Library of Medicine and the Association of American Medical Colleges, detailed a future of information management which addresses all of the needs noted above. And it laid out a key role for the library and librarians in achieving this future. The major thrust of the Matheson report is that there are many kinds of information and information systems in place in academic health science centers, but they are isolated from each other and from potential users. The integration of these various information resources would lead

to improved efficiency and effectiveness in the use of information in meeting
the goals of the institution. The library is only one of the sources of informa-
tion but an important one and has, in addition, the value of being viewed by
the institution and its constituents as a central service. Thus the library can
play a critical role in participating in the development of the application of
information systems technology.

The significance of the Matheson report to our topic today is in viewing the
library as an agent of change. Politically, the library is the most neutral of all
of the academic health science center's information-management units. It is
already viewed as an institutional resource that seeks support not for itself,
but for its users. Librarians are well conditioned to accept the change required
by full-scale automation. The library as an organization has well-established
goals, appropriate staff, and is ready for change. Finally, improved computer
technology is now well within the library's grasp financially. Major barriers
to the library's acting as an agent of change, however, are the traditional view
of the library as a passive entity, and the stereotype of the librarian as a
nonassertive partner in the activities of the health sciences center.

To begin this change, the Matheson report lays out five goals for manage-
ment of academic information resources: Establish a network capability by
automating all managerial and operational functions of the library; use this
capability to have the library serve as the institution's bridge to external data
bases; extend the library's technical information management services (in-
cluding indexing, editing, and management of personal and information files)
to all center personnel; interface with other information systems within the
center; and integrate new information system capabilities with educational
and other programs of the center. And six functional responsibilities are
recommended for the library: the library should continue as curator of the
resources necessary to meet the primary information needs of the academic
health sciences center; librarians should be actively involved in education; the
library should support the transfer and use of information; the library should
accept the responsibility to study fundamental research questions related to
storage, organization, and use of biomedical information; the library should
serve as a broker of information from both internal and external sources; and
the library should serve as a technical consultant in the area of information
management.

The library is identified in the Matheson report as a focal point for this
change because it can and will change. Libraries already have, and are
accustomed to, network capabilities. They are familiar with, and in many
instances already use, system-to-library networks, library-to-library net-
works, and library-to-user networks. Libraries are also well aware of their
responsibilities of curatorship, education, service, and research. Although

many libraries still do not yet have the technical support to operate effectively in each of these areas, they are aware of their responsibility to carry out these functions, and it is generally recognized by others in health science centers that these are legitimate functions of the library. Continued development of libraries along the lines outlined by the Matheson report will bring us closer to meeting health professionals' information needs.

And these continued developments are being supported by the second major publication, *Challenge to Action: Planning and Evaluation Guidelines for Academic Health Sciences Libraries*.[7] This report was sponsored by the Association of Academic Health Science Library Directors and the Medical Library Association and was partially supported by the Council of Library Resources and the National Library of Medicine.

Part One of *Challenge to Action* also addresses trends in our environment. The development of information handling systems in the medical center will be accomplished through the existing organizational structure and according to institutional policies. The library will be affected by this development as resources are allocated to the information handling system. Our experience in this area makes us logical partners in this enterprise. A cooperative approach between the library, institutional administration, the computer center, and other information producers and users in the institution will assure an integrated approach to information management. High quality library management during this period of change is necessary for effective use of resources.

The information explosion is clogging the traditional pipelines through which information flows. Therefore, the collection, organization, and distribution of information are activities that require effective management. It is important, however, to distinguish between management and control. Any integrated information system development must maintain the distinction between managing the flow of information and control of the content of that flow to be successful.

New computer and telecommunications technology speed the exchange of information, and effective communications networks facilitate the interaction between disparate and often distant members of the network. This new technology must serve the mission of the institution and not that of the managers of the network. Consideration of centralized or decentralized configurations and to compatibility or standards for hardware and software will be critical. Those responsible for administrative and academic computing, for hardware and telecommunications development, for systems development, and for libraries must work together in a coordinated strategic planning effort.

Basic medical education, as reflected in the curriculum, is changing to take advantage of new technologic capabilities. This, in turn, requires increased expertise in technology on the part of staff to orient students to the systems

which now will deliver the major portion of their education. Libraries have already begun to assume an increased educational support role. As the increasing volume of information and new systems for handling it develop, there will be a concomitant need to support faculty and staff through educational support activities, instruction for developing information management skills, and by providing access to information handling systems.

Increasing financial pressures require economies of scale and elimination of duplication within the institution. The library is only one among many institutional components seeking support for the application of information technology. The basic economics of information are not well known and research in this area is necessary for effective decision making. New information systems should not be developed on cost-analysis factors alone. The value of the library's information handling capability must be articulated if the library is to be a major partner in these developing information handling systems.

But *Challenge to Action* goes beyond just identifying trends. It lays out a series of guidelines in the areas of library management, the changing framework of information, technological advances, educational changes, and financial constraints. These guidelines are a blueprint for library activities in response both to the changing nature of information systems technology and to the new information needs of medical professionals. And so the stage is set for a new approach to meeting these information needs. And on that stage the medical library and librarian will play a prominent part. Which brings us to the last part of this analysis of the library's role: how can we determine how well that part is played?

EVALUATION OF LIBRARIES

To assess the effectiveness of the library's role in medical education will require, first, a new definition of that role. I started my analysis with some observations regarding how users viewed libraries and I was somewhat chastising in those observations. I certainly did not intend to denigrate the views of the many health professionals who have been staunch supporters of libraries nor did I intend to diminish the need to view libraries as important elements in the medical educational environment. What I did intend to do was to show how changes in that environment and trends in both medical education and information systems technology called for a new role for libraries. I hope that I have provided sufficient substantiation for a new paradigm for libraries and librarians.

Two observations from the survey, noted above, pertained to the question of evaluating libraries and/or medical schools. The first was that size of the library's collection should not be the main measure of quality and the second was that the quality of the library information retrieval facilities was of only middling importance in determining the overall standing of a medical school. Two issues were not addressed by the survey, the first being the question of the utility of information and the second being the library's role as a broker of institutional resources. The new paradigm for medical libraries incorporates all of these issues.

The library of the 21st century will be an academic information management library, as described in the Matheson report. It will have fully developed library-to-library and library-to-user communications and will be linked to the organizational information resource base. All institutional staff and students will have their own computers and be connected through an institution-wide telecommunications system. All of the library's records and services will be available on-line as will other information resources linked to the system. The library will be smaller, consisting of current books, journals, and nonprint media, but most of the collection will be on videodisk or other types of electronic storage. The library will access knowledge bases and librarians will work with faculty members to develop new knowledge bases. The library will be an information center that generates, stores, and integrates information systems. And the library will serve as a management center for a variety of computer-based files using technology to augment human information processing.

If this is the vision for medical libraries, then what is needed to accomplish the vision? The first is a strategic plan to manage information within the institution. The second is resources for both the technology and the personnel. And the third is a way to measure progress. The strategic plan requires only commitment by the leadership of the institution. The individuals who are ultimately responsible for the management of institutional resources need to see information as one of the most important resources they manage. If information is thought of as a commodity, it deserves management attention, which implies planning. And a major partner in that institutional planning should be the librarian.

The resources issue will be more difficult. Every part of the institution has financial needs and each considers itself critical to the mission of the institution. We have already seen that the library or information systems are not considered to be that important to that institutional mission. But if the plan-

ning for information use is carried out objectively, it will be possible to show that investments in information technology pay dividends for other components of the institution. High quality information services may free-up resources that are now being consumed in accessing information so that the investment in information services is viewed as of value to all. And the critical educational mission of the institution will be more effectively accomplished. I would suggest that, by the turn of the century, the quality of the management of institutional information in support of the educational process will be viewed much more critically then it is today.

The last step in realizing this new vision is that of measuring progress, evaluation, for if the library is to take on this new role and become a major partner in managing the institutional information resource base, there needs to be a new way to judge how well that new role is being fulfilled. In my introduction I was critical of both the present practice of measuring library quality in quantitative terms, i.e., size of collection as well as of the view that libraries should collect everything that would likely be needed, an impossibility today. I would substitute qualitative evaluation measures instead. The library should be evaluated based on its programs and services, its ability to access and manage information for its clients. The numbers game is a futile one. Not only is the ability to amass large, comprehensive collections beyond the grasp of most libraries, but the institutional environments of medical educational institutions are so different that comparisons between libraries are meaningless and irrelevant. Thus, a focus on qualitative evaluation would be consistent with both this new vision of information management and a stimulus for its implementation.

Second, a qualitative approach would enable the institution to focus on the integration of information resources. At the present time an evaluation of the library on quantitative measures provides information only on one component of information resource and use. It provides no information about other information resources within the institution and how those resources are used in the educational process. One of the primary concepts underlying the Integrated Academic Information System is the accessibility of the total information resource of the institution. The degree to which the library is a part of such an integrated system is a measure of how well the institution is using its information resources. And since the library, after the faculty, is the major provider of information resources for education, it is reasonable to assess the degree to which its information management capability is integrated with other information resources. The measure must be more than the number of databases accessed by the library or the number of connections to other

systems. It must address how library services exploit information access for learning which would include the degree of involvement of the library in the educational process itself. Integration, in this sense, is more than connectivity. It is integration into the curriculum to address the new needs arising from changes in medical education.

The last evaluation measure I would propose is the relationship between the library's programs and services and the institutional strategic plan for managing institutional information resources. Again, the higher the degree of correspondence between these two areas, the greater the efficiency and effectiveness of the institution in achieving its educational mission. This area is influenced by the extent to which the library is involved as a full partner in planning for the use of information. As noted above, the library is ready to play such a role. Its position within the institution, its responsibility for managing one of the major information resources, its level of application of information technology, and its historical role in information management, including training students in information access and retrieval, all place the library in a key position to fulfill this role. Thus, a measure of how library programs and services fit within the institutional strategic plan becomes a measure of the quality of the institution's educational program.

And so a new evaluation process of the library is required, one that measures these new, qualitative aspects. It starts with a measure of the involvement of the library in strategic planning for information use, continues through the degree to which the library participates in information systems for access and retrieval of information, the level of application of information systems technology within the library itself, and the degree to which the library is engaged in research on the utility of information, and ends with the variety of collaborative activities with faculty in the instruction of students in information management. And to the degree to which progress can be measured along these new dimensions, the library and the institution can be viewed as operating within this new paradigm.

CONCLUSION

We have come a long way in our journey. It started with an analysis of new information needs arising from trends in medical education. It traversed the information needs of a representative sample of information users. It surveyed possible solutions available through the application of information systems technology and the medical library. It has led us to a new paradigm for medical libraries and librarians for dealing with these information needs.

And it has shown us a new way to evaluate the library and the institution in responding to these needs.

I noted above the publication, *Challenge to Action*,[7] and characterized it as a blueprint for library activities. It is actually more than that for it will serve as a guide to planning and evaluation as well. *Challenge to Action* provides a set of goals for medical libraries and librarians and will be used to create new library programs and services. With these new goals come new criteria for evaluating progress towards the goals. Since the goals are qualitative, the evaluation measures will be qualitative and so the change to this new paradigm has begun.

We started our journey with an assessment of problems in dealing with information management. Our reasons for gathering here today were in response to those problems and our hope was that we could begin to formulate a new approach. What has been demonstrated by the presentations is a classic approach to problem solving. First there needs to be a recognition that a problem exists. I believe that we have heard ample evidence that such is the case. Next comes the need for information that bears on the problem. And here again I feel that we have heard enough to indicate that there are ways to address this problem. And last, there is the decision to apply the mechanisms available to begin solving the problem. That step is left for each of you to pursue within your own environment in a way that is most appropriate.

The information explosion is real. It will not disappear and ignoring it is foolhardy. It involves such disparate elements as the economics of scientific publication and promotion and tenure. Ample data to substantiate this problem and some of those data have been presented today. And the problem cannot be solved by focusing on the library alone. The level of the solution is not at the level of the problem. It requires the cooperation of the administration and faculty members of our medical educational institutions. It will require an active commitment to the management of institutional information resources. And it will require the active participation of all those professionals who have a responsibility for both producing information and managing it. The solution lies in the cooperation of the administration of our institutions with those at the level of responsibility for the problem, promotion and tenure committees, faculty members who create information, editors and publishers who are the gatekeepers for information dissemination, and librarians who deliver information.

And I am sure that, having participated in this systematic approach to the problem, we are now ready to take that first step on our next journey—a journey into the future of information systems for the medical sciences and one that will ultimately lead us to the library of the 21st century.

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